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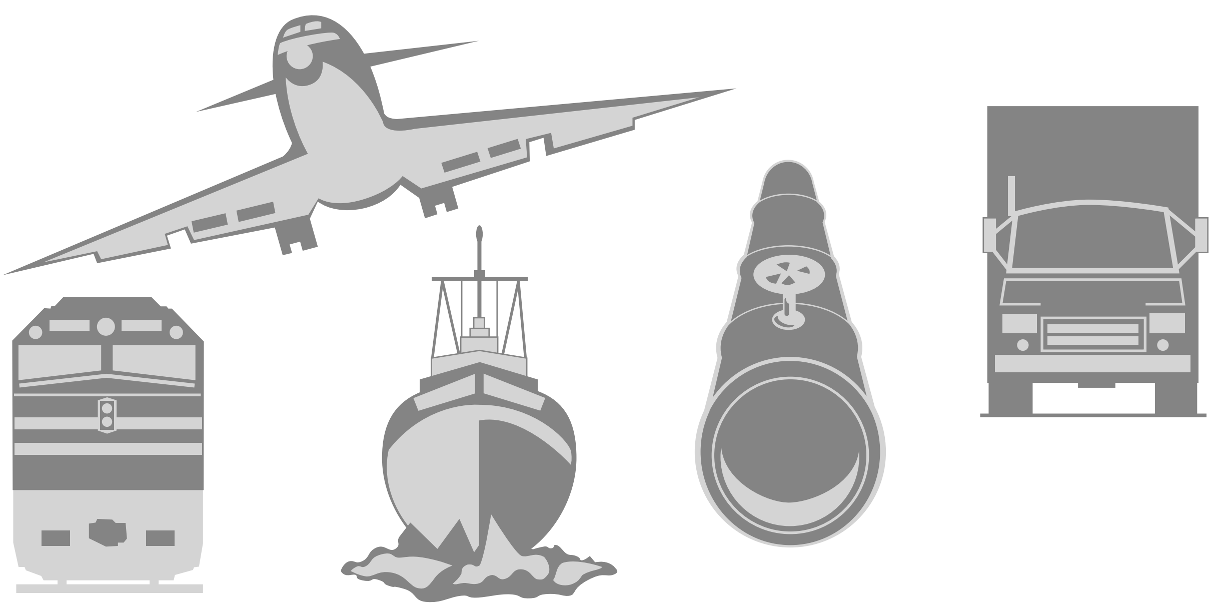
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY RECOMMENDATIONS

ADOPTED OCTOBER 2002



National Transportation Safety Board
Washington, D.C. 20594

Safety Recommendation

Date: October 7, 2002

In reply refer to: A-02-33 through -35

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Flat light is "the diffuse lighting that occurs under cloudy skies especially when the ground is snow covered. Under flat light conditions, there are no shadows cast, and the topography of snow-covered surfaces is impossible to judge."[1] Flat light[2] greatly impairs a pilot's ability to perceive depth, distance, altitude, or topographical features when operating under visual flight rules (VFR). Whiteout[3] is a similar phenomenon. Under these conditions, pilots may become spatially disoriented, unable to maintain visual reference with the ground, and unaware of their actual altitude.

Accidents Involving Flat Light Conditions

On June 9, 1999, about 1050 Alaska daylight time, a Eurocopter AS-350BA helicopter, N6099S, was destroyed when it crashed on the Herbert Glacier (part of the Juneau ice field) near Juneau, Alaska. The helicopter was being operated by Coastal Helicopters as a VFR, on-demand sightseeing flight under 14 *Code of Federal Regulations* (CFR) Part 135. The certificated commercial pilot and six passengers were killed. The accident pilot was not instrument rated.

The accident site was a level glacier surface covered by unbroken snow and located in a mountainous bowl surrounded by snow-covered peaks. The nose-down attitude and velocity of the helicopter at impact were consistent with a loss of control in flight and spatial disorientation. Two other pilots in the vicinity at the time of the accident reported VFR conditions but noted that the snow-covered glacier was featureless and that the overcast ceiling was difficult to distinguish from the snow. Accident site photographs taken by rescue personnel and Alaska state troopers about 1 hour after the accident revealed no discernible horizon.

1 Sandia National Laboratories, *Project ES&H Plan for NSA/AAO Climate Project*, SP473406, page 11.
2 Flat light conditions also may occur under similar circumstances over broad expanses of water.
3 Federal Aviation Administration (FAA) Advisory Circular AC-00-61 describes "whiteout" as a "visibility-restricting phenomenon that occurs in the Arctic when a layer of cloudiness of uniform thickness overlies a snow or ice covered surface. Parallel rays of the sun are broken up and diffused when passing through the cloud layer so that they strike the snow surface from many angles. The diffused light then reflects back and forth countless times between the snow and the cloud eliminating all shadows. The result is a loss of depth perception."

The National Transportation Safety Board determined that the probable cause of this accident was as follows:

> The pilot's continued VFR flight into adverse weather, spatial disorientation, and failure to maintain aircraft control. Factors associated with the accident [included] . . . "flat" lighting leading to whiteout conditions. Additional factors were the pilot's lack of instrument experience, inadequate certification and approval of the operator by the [Federal Aviation Administration], and the FAA's inadequate surveillance of the emergency instrument procedures in use by the company.

On September 10, 1999, about 1204 Alaska daylight time, a Eurocopter AS-350B-2 helicopter, N6007S, was destroyed when it crashed on the Juneau ice field near Juneau, Alaska. The helicopter crashed on a level surface while flying near cruise speed, in a level attitude. The helicopter was being operated by TEMSCO Helicopters (TEMSCO) as a VFR, on-demand sightseeing flight under 14 CFR Part 135. The certificated commercial pilot and four passengers received minor injuries. The remaining passenger received serious injuries. The pilot was not instrument rated.

The pilot said that, during a gradual descent over a large, featureless, snow-covered ice field, a localized light snow shower momentarily reduced his forward visibility. He also stated that he was "unable to discern any topographic features, only a dark shape on the horizon." He stated that immediately before impact, he believed the helicopter was 500 feet above the surface. Three pilots who were in the area at the time of the accident all stated that overcast conditions, localized snow showers, and flat light conditions hindered their ability to discern the surface of the glacier. They added that weather reports and forecasts from Juneau often did not represent the actual weather in the mountains and over the ice field.

The Safety Board determined that the probable cause of this accident was as follows:

> The pilot's continued flight into instrument meteorological conditions (IMC), and inadequate altitude/clearance. Factors associated with the accident were flat light and whiteout conditions, snow, and snow-covered terrain. An additional factor was the FAA's inadequate certification/approval of the operator's training manual, which did not require the operator to provide instrument training or instrument flight proficiency checks to its pilots.

On September 10, 1999, about 1445 Alaska daylight time, a Eurocopter AS-350B-2 helicopter, N6052C, sustained substantial damage when it crashed on the Juneau ice field near Juneau, Alaska. The helicopter was being operated by TEMSCO as a VFR search and rescue flight under 14 CFR Part 91. (The crew of N6052C was searching for N6007S when it crashed.) The certificated commercial pilot and the one passenger were not injured. The accident pilot was not instrument rated.

The pilot said that, while searching the upper portion of the ice field, deteriorating weather conditions to the north and east required him to proceed south, down the ice field. He stated that he slowed the helicopter to 15 knots and attempted to use a mountain ridge to the right of the helicopter (that is, west) for visual reference. He said, "Visibility in front was enough to see all the way to the top of the Herbert (greater than 3 miles). The ceiling sloped down to the east 45º with a height at the ridge of approximately 700 feet." The pilot added that just seconds before the impact, he thought the helicopter was at least 500 feet above the surface. He stated that flat light conditions made it difficult to see the ice field below.

The Safety Board determined that the probable cause of this accident was as follows:

> The pilot's failure to maintain altitude/clearance. Factors associated with the accident were flat light conditions, snow-covered terrain, and self-induced pressure to continue the search.

On September 10, 1999, about 1630 Alaska daylight time, a Eurocopter AS-350B-2 helicopter, N6099Y, sustained substantial damage when it crashed on the Juneau ice field near Juneau, Alaska. The helicopter was being operated by TEMSCO as a VFR search and rescue flight under 14 CFR Part 91. (Like the crew of N6052C, the crew of N6099Y was searching for N6007S when it crashed.) The certificated commercial pilot and the three passengers were not injured. The accident pilot was instrument rated but did not meet instrument currency requirements and had not been tested for instrument proficiency on his last 14 CFR Part 135 helicopter flight check.

The pilot of N6099Y stated that he was able to locate the downed helicopter (N6007S) about 2 miles in front of him. He said that he slowed the helicopter to about 30 knots in an attempt to gain visual reference by using a mountain range to the left of the helicopter and the debris field associated with the N6007S accident site to the front of the helicopter. He said that the ceiling at this location was at least 1,000 feet above ground level, and visibility in the direction of N6007S was more than 6 miles. He added that just before impact, he thought he was at least 500 feet above ground level. The pilot said that flat light conditions hampered his ability to see the topographical features of the ice field below.

The Safety Board determined that the probable cause of this accident was as follows:

> The pilot's failure to maintain altitude/clearance. Factors associated with the accident were flat light conditions, snow-covered terrain, and self-induced pressure to continue the search.

On May 1, 2000, about 1230 Alaska daylight time, a Bell 206B helicopter was destroyed when it crashed into snow-covered terrain about 21 miles northeast of Homer, Alaska. The helicopter was being operated by Maritime Helicopters, Inc., as a VFR, on-demand charter flight under 14 CFR Part 135. The airline-transport certificated pilot and the two passengers were not injured. The pilot stated that sky conditions at the accident site were about 500 feet overcast, and the visibility was about 1 mile. He said that flat light conditions existed, and that light drizzle was falling. He stated further that he was using a building as a landing reference, but when he flew past the building during the landing approach, he had no other visual references. The left landing gear skid of the helicopter contacted the snow, and the helicopter rolled onto its left side. The accident pilot was instrument rated but did not meet instrument currency requirements and had not been tested for instrument proficiency on his last 14 CFR Part 135 helicopter flight check. In answer to the question, "How could this accident have been prevented?" on the *Pilot/Operator Aircraft Accident Report,* the pilot responded, "additional white-out training."

The Safety Board determined that the probable cause of this accident was "the pilot's misjudging the landing flare in whiteout/flat light conditions. Factors associated with the accident are the whiteout and flat lighting conditions."

For each of these five accidents, visual meteorological conditions prevailed at the time of the helicopters' departure. None of these helicopters were equipped with radar altimeters, nor were they required to be.

Safety Issues

Since January 1997, flat light conditions have been mentioned in the probable cause for 23 aviation accidents investigated by the Safety Board, including the five helicopter accidents described in this letter. In addition, whiteout conditions have been mentioned in another 13. Nearly all of these accidents occurred in Alaska. Although all but eight of the accidents involved fixed-wing aircraft, it is clear that flat light conditions occur relatively frequently in Alaska and create hazards for aircraft. The Board is concerned that, with the increasing popularity of helicopter tours in Alaska, additional safety measures are warranted for commercial helicopter operations there, where flat light and whiteout conditions are likely to occur. (According to a draft Environmental Impact Statement prepared by U.S. Forest Service,[4] the total number of landings on the Juneau ice field increased from approximately 2,000 in 1985 to approximately 16, 500 in 2000.)

Evidence gathered during the investigation of the five accidents described in this letter raises the following concerns about commercial helicopter operations during flat light and other IMC: (1) commercial helicopter pilots who operate in areas where flat light or whiteout conditions routinely occur are not required to be instrument rated or to demonstrate instrument competency during Part 135 evaluation check flights; (2) commercial helicopter operators in these areas do not provide their pilots with the training necessary to operate safely in flat light conditions; and (3) radar altimeters that might aid pilots in recognizing proximity to the ground in flat light and whiteout conditions are not required for helicopters.

Instrument Flight Rating and Competency

Helicopters may legally operate in visibility less than that prescribed for airplanes (see 14 CFR 135.205(b) and 135.207). Title 14 CFR 135.207 reads, "No person may operate a helicopter under VFR unless that person has visual surface reference or, at night, visual surface light reference, sufficient to safely control the helicopter." However, the accidents described in this letter demonstrate that flat light and whiteout conditions may arise without warning, thus creating the potential for losing sight of terrain. Further, the accidents demonstrate that, in such conditions, helicopters may not always operate at airspeeds slow enough to avoid obstructions and terrain.

[4] *Helicopter Landing Tours on the Juneau Icefield, 2002 - 2006, Draft Environmental Impact Statement,* July 27, 2001.

During its investigation of the June 9, 1999, helicopter accident on the Juneau ice field, Safety Board staff interviewed pilots from different helicopter companies. All confirmed that weather conditions reported at the Juneau airport often vary significantly from conditions on the various glaciers flowing from the Juneau ice field. These pilots also stated that weather conditions tend to be local in nature due to mountainous terrain, wind, and temperature variations associated with the large mass of ice. Pilots interviewed during investigation of the September 10, 1999, accidents stated that weather reports and forecasts from Juneau often do not represent the actual weather conditions in the mountains and over the ice field.

Safety Board investigators also asked Coastal Helicopters' chief pilot if he conducted any training for emergency use of basic flight instruments. He replied that he did not and emphasized that company policy was to "go down, and slow down, but never go into instrument meteorological conditions." When asked what he would do personally if he found himself in whiteout or IMC, he replied that he never intended to be in that situation. The company's president, who also served as director of operations, stated that company policy was that a pilot does not fly into instrument conditions. Regardless of the views of the chief pilot and the president of Coastal Helicopters, the Safety Board doubts that pilots who routinely operate in areas where flat light or whiteout conditions routinely occur will always be able to avoid operating in such conditions, as the accidents described in this letter demonstrate.

Currently, the basic aeronautical training requirements contained in 61 CFR Part 129 require commercial and/or private helicopter pilots to receive 10 hours of instrument training in "an aircraft"; the CFR does not require instrument training for helicopter operations specifically, nor does it address the special hazards presented by flat light and whiteout conditions. Title 14 CFR 135.293(b) does require pilots to pass a competency check "to determine the pilot's competence in practical skills and techniques in that aircraft or class of aircraft [that is, helicopters]. The extent of the competency check shall be determined by the Administrator or authorized check pilot conducting the competency check." To that end, FAA Order 8400.10, *Air Transportation Operations Inspector's Handbook*, volume 3, chapter 2, section 7, paragraph 539, provides guidance for FAA principal operations inspectors (POIs) to use in reviewing and approving basic checking modules. Paragraph 539 of the order states that the minimum acceptable content of a Part 135 annual competency check for both fixed-wing and helicopter pilots should include some demonstration of "the pilot's ability to maneuver the aircraft solely by reference to instruments." Accordingly, the order specifies that competency checks for helicopter pilots (even those who conduct VFR-only operations) should include instrument approaches to demonstrate that the pilots are able to take a reasonable course of action to escape an inadvertent encounter with IMC.

Although POIs are expected to follow FAA Order 8400.10, implementation of the instrument-competency portions of paragraph 539 has occurred inconsistently and in some instances, not at all. None of the operators involved in the accidents described in this letter (that is, Coastal Helicopters, TEMSCO, and Maritime Helicopters) had included, nor had their POIs required them to include, a demonstration of IFR competency in their annual competency checks.

The Safety Board is concerned that helicopter pilots who conduct commercial, passenger-carrying flights in areas where flat light or whiteout conditions routinely occur are not required to hold helicopter instrument ratings[5] or to demonstrate IFR competency during initial and recurrent 14 CFR 135.293 evaluation flight checks. The accidents described in this recommendation letter might have been prevented if the pilots who were involved were instrument rated and instrument proficient. Therefore, the Safety Board believes that the FAA should require all helicopter pilots who conduct commercial, passenger-carrying flights in areas where flat light or whiteout conditions routinely occur to possess a helicopter-specific instrument rating and to demonstrate instrument competency during initial and recurrent 14 CFR 135.293 evaluation check flights.

The Safety Board also believes that the FAA should require all commercial helicopter operators conducting passenger-carrying flights in areas where flat light or whiteout conditions routinely occur to include safe practices for operating in flat light and whiteout conditions in their approved training programs.

Radar Altimeters

The helicopters described in this letter were neither equipped nor required to be equipped with radar altimeters, which indicate the aircraft's actual height above the ground and which warn pilots of their aircrafts' proximity to terrain. However, the Safety Board's position is that the helicopter accidents described in this letter, which occurred in the presence of flat light or whiteout conditions over featureless, snow-covered terrain, might have been prevented had the helicopters been equipped with radar altimeters. Therefore, the Safety Board believes that the FAA should require the installation of radar altimeters in all helicopters conducting commercial, passenger-carrying operations in areas where flat light or whiteout conditions routinely occur.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require all helicopter pilots who conduct commercial, passenger-carrying flights in areas where flat light or whiteout conditions routinely occur to possess a helicopter-specific instrument rating and to demonstrate their instrument competency during initial and recurrent 14 *Code of Federal Regulations* 135.293 evaluation check flights. (A-02-33)
>
> Require all commercial helicopter operators conducting passenger-carrying flights in areas where flat light or whiteout conditions routinely occur to include safe practices for operating in flat light or whiteout conditions in their approved training programs. (A-02-34)
>
> Require the installation of radar altimeters in all helicopters conducting commercial, passenger-carrying operations in areas where flat light or whiteout conditions routinely occur. (A-02-35)

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[5] Title 14 CFR 135.243(a)(2) requires helicopter pilots engaged in scheduled commercial interstate flights within the contiguous 48 states to have an instrument rating.

Acting Chairman CARMODY and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Carol J. Carmody
Acting Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 11, 2002

In reply refer to: P-02-4 and -5

Honorable Ellen G. Engleman
Administrator
Research and Special Programs Administration
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About 3:28 p.m. on June 10, 1999, a 16-inch-diameter steel pipeline owned by Olympic Pipe Line Company ruptured and released about 237,000 gallons of gasoline into a creek that flowed through Whatcom Falls Park in Bellingham, Washington. About 1 1/2 hours after the rupture, the gasoline ignited and burned approximately 1 1/2 miles along the creek. Two 10-year-old boys and an 18-year-old young man died as a result of the accident. Eight additional injuries were documented. A single-family residence and the city of Bellingham's water treatment plant were severely damaged. As of January 2002, Olympic estimated that total property damages were at least $45 million.[1]

The National Transportation Safety Board determined that the probable cause of the June 10, 1999, rupture of the Olympic pipeline in Bellingham, Washington, was (1) damage done to the pipe by IMCO General Construction, Inc., during the 1994 Dakin-Yew water treatment plant modification project and Olympic Pipe Line Company's inadequate inspection of IMCO's work during the project; (2) Olympic Pipe Line Company's inaccurate evaluation of in-line pipeline inspection results, which led to the company's decision not to excavate and examine the damaged section of pipe; (3) Olympic Pipe Line Company's failure to test, under approximate operating conditions, all safety devices associated with the Bayview products facility before activating the facility; (4) Olympic Pipe Line Company's failure to investigate and correct the conditions leading to the repeated unintended closing of the Bayview inlet block valve; and (5) Olympic Pipe Line Company's practice of performing database development work on the supervisory control and data acquisition (SCADA) system while the system was being used to operate the pipeline, which led to the system's becoming non-responsive at a critical time during pipeline operations.

In December 1998, Olympic completed construction of the new Bayview products terminal about 2 miles upstream of the existing Allen station. Because the accident pipeline entering the terminal could be operated at pressures considerably higher than the pressure limit for the terminal, three control devices were employed to protect station piping and components

[1] For additional information, see National Transportation Safety Board, *Pipeline Rupture and Subsequent Fire in Bellingham, Washington, June 10, 1999*, Pipeline Accident Report NTSB/PAR-02/02.

from overpressure. First, a control valve, CV-1904, was installed on the inlet side of the station and set at 600 pounds per square inch, gauge, (psig) to throttle back the flow of product into the station. Second, a relief valve, RV-1919, was installed just downstream of the control valve. The relief valve was designed to open and transfer excess product to the transmix tank if the pressure downstream of CV-1904 exceeded the set pressure of the relief valve.

Finally, a receiver manifold arrangement, consisting of three motor-operated and remotely controlled block valves (MV-1902, MV-1903, and MV-1907) controlled product flow upstream of control valve CV-1904. Either MV-1902 or MV-1903, depending upon the selected configuration, was set to close in approximately 60 seconds and completely block the flow of product into the Bayview terminal if a set pressure of 700 psig was reached inside the facility.

RV-1919 was an 8-inch Brooks Model 760 pilot-operated control valve[2] manufactured by Fisher-Rosemount. The valve is designed to remain closed until the pressure in the pipeline on the inlet side of the valve reaches a predetermined pilot set point. When this pressure is reached, the pilot opens, allowing the relief valve itself to open and permit product flow through the valve. The Model 1760 pilot is available in either a low-pressure (0 to 180 psig) or a high-pressure (150 to 650 psig) configuration. The two configurations have different pistons, valve covers, and O-rings. Because an employee of the valve vendor apparently misinterpreted the valve specifications, the vendor configured RV-1919 as a low-pressure relief valve with a set point of 100 psig. Even though all the valve documentation and the valve itself indicated that RV-1919 was configured as a low-pressure valve, this went unnoticed by Olympic.

During the night from December 16 into December 17, 1998, Olympic personnel began filling the pipeline to bring the Bayview facility into operation. The employees noted that as the accident pipeline filled and the pressure increased above 100 psig, RV-1919 opened and diverted product to a breakout tank. The employees recalled that the engineering manager was on the site during this activity and that when he noticed that the relief valve was operating at a pressure lower than intended, he reviewed drawings and directed efforts to determine why this was happening. The employees were aware that the available pressure range adjustment on the relief valve was limited by the type of pilot spring. Without consulting the manufacturer's literature on the valve, which was available, the employees decided that they could increase the set point by replacing the pilot spring. One of the mechanics had a spring in his truck that he gave to another of the mechanics who used it to replace the existing pilot spring in RV-1919. The set point was then increased, after which the employees were able to fill and pressurize the pipeline. The mechanic was not aware that, because the same spring was used for either the 70- to 180-psig or the 350- to 650-psig pressure ranges, depending on the valve configuration (high or low pressure), the spring that he placed in RV-1919 was identical to the one he removed. He said that after he increased the set point, he used a hydraulic pump to apply pressure to the pilot to determine the pressure at which the pilot operated.[3] He said he tested the pilot several times and that it opened at the correct pressure each time.

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[2] Although "control valve" is the terminology used in the Brooks literature, RV-1919 functioned as a pressure relief valve in this installation.

[3] To conduct the test, the mechanic isolates the pilot from the main relief valve and applies hydraulic pressure to the pilot through the sensing line. A gauge on the test unit registers (by showing a drop in pressure) the point at which the pilot operates. This is the same test the company used to perform annual valve tests required by Federal regulation.

It was determined during the evaluation of the relief valve after the accident that the pilot spring had been compressed to the point that the rising inlet pressure could not lift the piston, rendering operation of the pilot valve completely unreliable. Even though the mechanic who replaced the valve spring in RV-1919 and reset the pressure set point said he tested the pilot several times using the same test procedure the company used for annual valve tests, those tests did not reveal that the valve was improperly configured and thus would not consistently open at the intended set pressure. If this valve did not open and the pressure at the Bayview terminal increased above 700 psig, the inlet block valve upstream of the Bayview terminal would close and increase pressure across the damaged section of Olympic pipeline, which is what occurred on the day of the accident.

Federal regulations at 49 CFR Part 195 require pipeline operators to test pressure limiting devices, relief valves, and other pressure control equipment once each calendar year at intervals not exceeding 15 months to determine that they are functioning properly, are in good mechanical condition, and are adequate from the standpoint of capacity and reliability of operation for the service in which they are used. These regulations do not identify specific testing procedures to be used to determine whether the relief valve is functioning properly. Although RV-1919 was a new valve and not yet subject to the requirement for periodic inspections, the annual inspections that Olympic performed on other relief valves within its system consisted of a visual inspection and a test to determine the set point of the pilot. The test used to check the set point was the same one used by the mechanic to test the operation of RV-1919. But, as noted above, the tests used by Olympic were inadequate to determine whether the pilot was configured properly or whether the relief valve was operating reliably. The Safety Board concluded that the Federal regulations establishing performance standards for the testing of relief valves and other safety devices installed on hazardous liquid pipelines provide insufficient guidance to ensure that test protocols and procedures will effectively indicate malfunctions of the relief valves and/or their pilot controls.

On the day of the accident, the SCADA system that controllers used to operate the pipeline became unresponsive, making it difficult for controllers to analyze pipeline conditions and make timely responses to operational problems. The SCADA system became unresponsive at a critical time, as the controller was attempting to switch delivery points. Had the controller been able to operate the pipeline normally using the SCADA system, it is probable that the pressure backup that accompanied the change in delivery points would have been alleviated and the pipeline operated routinely for the balance of the fuel delivery. Even if the controller had been unable to prevent the pressure buildup and the subsequent closure of the inlet block valve at Bayview, had he had full SCADA control, he may have been able to slow down the pipeline sufficiently to reduce the severity of the pressure increase when the block valve did close. The Safety Board concluded that if the SCADA system computers had remained responsive to the commands of the Olympic controllers, the controller operating the accident pipeline probably would have been able to initiate actions that would have prevented the pressure increase that ruptured the pipeline.

Investigators attempted to determine why the SCADA system, which was not reported to have experienced operational problems before the accident, became slow or unresponsive at a critical time during the pipeline operations. About the same time the accident controller was preparing to change delivery points on the 16-inch pipeline, the SCADA system administrator was in the control center computer room entering two new records into the SCADA historical database. A few minutes after the new records were entered into the system, the SCADA computer began to generate error messages related to the historical database.

The SCADA problems grew more pronounced over the next 20 minutes, during which, at one point, the system became completely unresponsive. This period of non-responsiveness coincided with the rupture of the pipeline. The SCADA problems encountered by the controllers occurred shortly after the system administrator inserted the new records into the system computer and were resolved after the control center supervisor deleted the new records. Also, the systems administrator said that as the new records were being deleted, he noticed a typographical error in the records that had not been there when the records were checked earlier. Because of this and the fact that the SCADA system had not previously exhibited a similar non-responsiveness, the Safety Board concluded that the degraded SCADA performance experienced by the pipeline controllers on the day of the accident likely resulted from the database development work that was done on the SCADA system.

The system administrator was working on the "live" system. And even though the SCADA system was configured to permit alterations to be made to the historical database while the system was on line, the Safety Board does not consider this to be prudent practice. Computer systems, while they have proven their worth in all modes of transportation, are not infallible, nor are their operators and administrators. Newly developed computer routines do not always work correctly at first and must be revised. Sometimes, seemingly simple mistakes can result in catastrophic consequences, even on the most robust of operating systems. Olympic personnel used the operational system as a test bed to develop changes and upgrades to the database without first testing the changes on a separate off-line system.

SCADA developmental work or database modifications should be performed on a developmental workstation that allows any revisions to be thoroughly tested off line. Only after such tests have verified that the system works as intended and the testing has been reviewed by personnel trained in analyzing the test methods and results, should the changes be entered into the SCADA real-time computer. The Safety Board concluded that, had the SCADA database revisions that were performed shortly before the accident been performed and thoroughly tested on an off-line system instead of the primary on-line SCADA system, errors resulting from those revisions may have been identified and repaired before they could affect the operation of the pipeline.

The National Transportation Safety Board therefore makes the following safety recommendations to the Research and Special Programs Administration:

> Develop and issue guidance to pipeline operators on specific testing procedures that can (1) be used to approximate actual operations during the commissioning of a new pumping station or the installation of a new relief valve, and (2) be used to determine, during annual tests, whether a relief valve is functioning properly. (P-02-4)
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> Issue an advisory bulletin to all pipeline operators who use supervisory control and data acquisition (SCADA) systems advising them to implement an off-line workstation that can be used to modify their SCADA system database or to

perform developmental and testing work independent of their on-line systems. Advise operators to use the off-line system before any modifications are implemented to ensure that those modifications are error-free and that they create no ancillary problems for controllers responsible for operating the pipeline. (P-02-5)

Please refer to Safety Recommendations P-02-4 and -5 in your reply. If you need additional information, you may call (202) 314-6177.

Acting Chairman CARMODY and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Carol J. Carmody
Acting Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 11, 2002

In reply to refer to: I-02-05

Dr. Ashish K. Sen
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The National Transportation Safety Board relies on many external databases when performing accident investigations, safety studies, and special investigations. Most of these databases are sponsored and operated by the modal administrations of the U.S. Department of Transportation (DOT). The Safety Board's ability to study important safety issues is often affected by poor data quality. The Board studied transportation safety databases to evaluate data quality issues and encourage improvements in this area. The effort had four specific objectives: (a) highlight the value and potential uses of transportation safety data; (b) describe some accident and incident databases commonly used by the Board; (c) summarize past Board recommendations involving transportation data; and (d) evaluate Bureau of Transportation Statistics (BTS) efforts to establish data quality standards, identify information gaps, and ensure compatibility among the safety data systems maintained by the DOT.[1]

In reviewing BTS efforts to establish data quality standards, identify information gaps, and ensure compatibility between DOT safety data systems, the Safety Board recognizes a number of important BTS accomplishments. The BTS has drafted standards for data collection and analysis, and these standards are being refined as BTS staff gain experience during audits of existing DOT databases. The agency has published several reports identifying DOT safety data gaps, including *Information Needs to Support State and Local Transportation Decision Making*, published in 1997, and *Transportation Statistics Beyond ISTEA: Critical Gaps and Strategic Responses*, published in 1998. The BTS has identified additional gaps through its Safety Data Initiative and Data Gaps projects, which began in 1999 and 2001, respectively. In short, the BTS has led safety data improvement efforts in recent years, and the Safety Board commends the DOT's efforts in this area.

The Safety Board has issued a variety of recommendations seeking the improvement of transportation safety data. An analysis of past recommendations revealed that roughly 30 percent of the Board's data recommendations addressed the collection or use of exposure data in some way. These measures are needed to calculate broad safety indicators (for example, fatality

[1] National Transportation Safety Board, *Transportation Safety Databases,* Safety Report NTSB/SR-02/02 (Washington, DC: NTSB, 2002).

rates), risks for operational categories (for example, vehicle type comparisons), and to evaluate safety interventions (for example, seat belt use).

Broad indicators of transportation activity, such as vehicle miles, vehicle departures, hours of operation, or passenger miles, are available in all modes of transportation. These measures are commonly used to calculate accident and injury rates by qualifying how often a risk event had the chance to occur. Most activity measures are derived by estimation methods that vary by mode. For example, a vehicle census or an operator survey may be used to develop transportation activity estimates. Depending on the estimation method used, different activity measures will have varying levels of precision.

Although the Safety Board recognizes that broad indicators of transportation activity are well documented, activity measures specific to operational segments within a mode of transportation are less likely to be available. Activity measures for specific segments of transportation are necessary for safety comparisons between groups, such as comparing the safety of different models of vehicles or comparing operators with different levels of training. They are also useful for determining the effectiveness of safety interventions, particularly those designed to target specific operators, equipment, or conditions.

There are many examples of exposure data limitations that restrict the transportation community's ability to assess risk. In aviation, for example, the flight hour activity for air carrier nonrevenue flights are not reported, activity of air tour operators is based on survey responses from a small fraction of aircraft owners, and no reliable estimates of general aviation departures are available. Activity data are sparse for recreational boating, with only one national survey conducted in the last 10 years. Data describing activity at the Nation's highway–rail crossings are lacking. The U.S. Census Bureau conducts the Vehicle Inventory and Use Survey that estimates miles traveled, but that data cannot support comparisons of certain types of interstate versus intrastate operations. Estimates of active pipeline mileage are available, through the Federal Energy Regulatory Commission, for only some varieties of pipelines that carry potentially hazardous petroleum products. The collection of more detailed exposure data would support improved safety surveillance, making it possible to normalize accident trends within each sector and to monitor overall risk.

Many existing exposure data collection programs are insufficient to support the analysis of risk factors for transportation accidents because they lack adequate detail. For example, general aviation exposure data are expressed in terms of annual flight hours by aircraft category and region, but the Federal Aviation Administration (FAA) does not collect data describing the characteristics of active pilots, flight conditions, or specific models of aircraft flown. In the highway mode, the Federal Highway Administration (FHWA) collects highway exposure data including annual vehicles miles traveled, but the data do not describe driver characteristics, driving conditions, or specific vehicle models. In the marine mode, DOT databases provide no information on passenger or cargo movement via commercial vessels, and surveys of recreational boat use are conducted at infrequent, irregular intervals and therefore do not collect standard information over time. The Federal Railroad Administration (FRA) requires railroads to submit exposure data including train miles, freight train miles, and passenger train miles, but the FRA does not collect exposure data describing train or highway vehicle activity at highway–rail crossings despite the fact that hundreds more people die at grade crossings than die as train passengers. The Federal Transit Administration (FTA) collects transit exposure data including passenger miles traveled, vehicle miles traveled, vehicle hours, and unlinked passenger trips, but FTA exposure data contain little or no information about the population of transit users. Without detailed information about the people and vehicles involved in transportation activities, and the conditions under which such activities take place, it is difficult to assess the degree to which various factors may influence the likelihood and severity of transportation accidents. This circumstance lessens the usefulness of the relatively detailed data collected for transportation accidents as a tool for monitoring and improving transportation safety.

The BTS addressed exposure data issues as part of the Safety Data Initiative through its project 3, *Common Denominators for Safety Measures*. The term for that project's "common denominators" refers to the relationship between accident measures and representative exposure data that are used to assess transportation risks. The BTS report concluded that exposure data collection could be made more consistent across the modes, and recommended the collection of information such as trip length, trip time, number of vehicle occupants, and hours of duty for most modes. The BTS has also been developing its Omnibus Survey and its American Travel Survey to collect better data on household travel activity. These surveys may facilitate better analysis of risk factors for the most common forms of travel, such as personal highway vehicle travel. However, these surveys are not as useful for qualifying travel for specific types of vehicles or for specific purposes, such as commercial trucks. The Safety Board believes that the DOT's exposure data collection programs can be improved and expanded to better support the monitoring of accident risk for specific transportation sectors, to support the detailed analysis of risk factors, and to evaluate the effectiveness of strategies for preventing transportation accidents.

Any programmatic effort to improve exposure data collection and make it more relevant for safety data analysis will require the participation and expertise of the operating administrations of the DOT. It will also require consideration of the statistical methods to appropriately use the data. Congress made the BTS responsible for issuing data collection guidelines and implementing a comprehensive long-term data collection program. It is therefore logical that the BTS would be the appropriate agency to lead any DOT-wide effort to improve exposure data. The Safety Board concludes that the BTS should develop a long-term program to improve the collection of data describing exposure to transportation risk in the United States. Within each mode, representative exposure data should be maintained for distinct transportation sectors, industry segments, or travel purposes because these differences relate to unique operational and/or regulatory characteristics. These data should be collected in such a fashion that they are useful for (a) the normalization of accident data on at least an annual basis; (b) the analysis of risk factors involving people, vehicles, and environments; and (c) the evaluation of safety improvement strategies implemented at the State or national level.

Therefore, the National Transportation Safety Board recommends that the Bureau of Transportation Statistics:

> Develop a long-term program to improve the collection of data describing exposure to transportation risk in the United States. Within each mode, representative exposure data should be maintained for distinct transportation sectors, industry segments, and travel purposes. (I-02-05)

Please refer to Safety Recommendation I-2-05 in your reply. If you need additional information, you may call (202) 314-6177.

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.[2]

Original Signed

By: Carol J. Carmody
Acting Chairman

[2] At the time the report was adopted, on September 11, 2002, Marion C. Blakey was Chairman of the National Transportation Safety Board.